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COMPLEX PROBLEMS AND QUALITATIVE MODELLING

K. SASIDHAR and P.N. MURTHY

Systems Engineering and Cybernetics Centre,
Tata Consultancy Services, Hyderabad, India

Complex problems constitute one of the major areas of concern in the contemporary world. The behaviour of complex systems is often counterintuitive, defying the linear causal interpretation normally employed in problem solving. To handle these systems, there is need for new "tools of thought". Modelling proves very beneficial in discovering such tools and learning how to use them.[1].

Modelling is frequently associated with quantification. However,the real world complex problems are not entirely amenable for quantitative modelling. As L.Zadeh has commented, conventional quantitative techniques of system analysis are not particularly well-suited for dealing with complex systems. As the complexity of the system increases, our ability to make precise yet significant statements about its behaviour diminishes.

Most often a high degree of precision is not really called for, as a very approximate characterisation of the system would suffice. Therefore, for dealing with complex systems,"we need approaches which do not make a fetish of precision, rigor and mathematical formalism and which employ instead a methodological framework which is tolerant of imprecision and partial truths."[2].

In other words, the need is for certain qualitative modelling, which relies on approximation, partial truths and accepts ambiguity and incompleteness of information as essential aspects of reality. In a managerial world,where the manager seeks not the "optimal" answer but a workable solution, the emphasis is all the more on qualitative modelling.

Consulting which is concerned with the handling and resolution of managerial problems thus is naturally associated with qualitative modelling in a significant way. This paper discusses the nature of qualitative modelling and outlines the modelling approach adopted by the authors in handling real- world complex problems in consulting environment.

Epistemology of Modelling

As models are abstractions of reality, the epistemological aspects of modelling become relevant in this context. The different modes through which reality is congnized are presented by Sri Aurobindo in an epistemic hierarchy.[2]

According to Sri Aurobindo, we gather knowledge about the reality essentially in four modes, namely,

i. Knowledge by identity

ii. knowledge by intimate direct contact

iii. knowledge by separate direct contact

iv. a wholly separate knowledge by indirect contact.

Among these, the first mode of knowledge by identity is the most direct and comprehensive way of obtaining knowledge of any entity. At the other end, the fourth mode relies primarily on indirect approach and tries to obtain knowledge about the entity which is totally separate. This mode, in fact, is the precise reference to the method of modelling which does not involve plunging into the reality directly but understanding it indirectly through the agency of models. The set of models provide intermediation between the reality and ourselves in comprehending the complex reality

The modelling process can be examined effectively using the framework provided by Rosen.[4]. The two key elements in the framework are i)Natural System and ii) Formal System , both of which are connected through the modelling relation.

Natural system embodies a mental construct, which comprises a model pertaining to the organisation of the external world. A formal system is entirely a creation of mind unlike natural systems which are concerned with external world. Formal systems model the natural systems and serve as vehicles for drawing inferences from premises. In a sense, formal systems represent the second order models of the reality while the natural systems are the first order models.

Approaches to modelling

There are essentially two ways in which modelling can be attempted-- Bottom-up and top-down .

Bottom up approach

This method involves building up from the details and utilising knowledge from sub-systems to identify the character of the overall system. This is similar to the Identification Problem under Reconstructability Analysis.[8] The latter is the problem of identifying specified properties of an unknown overall system from the knowledge of the properties of some given set of sub systems. This implies a reconstruction of underlying reality out of partial and divergent perceptions. It means extraction of a higher order holistic configuration from a multiplicity of observations of lower order dimensions. In this approach, the property of emergence becomes very significant.

Top down thinking

This involves starting from a holistic idea or statement and systematically devolving to the micro realities. The Brahma Sutras of Indian philosophy are precisely such statements, which represent holistic cognition, in the most compact way. They are " highly concise, unambiguous, rich in content and multi-faceted." [5].

These statements, made at the highest levelof abstraction need to be systematically amplified and elaborated in order to extract their inherent richness and to bring out the multiple facets implicit in them.

This approach is well reflected in the Integrative Study advocated by Engelberg.[6] The integrative statements used in the Study are based on powerful insights of universal meaning. They are generally simple in form, though their implications are usually complex and each statement is a universe by itself.The more abstract and higher-level the statement is, the greater the interpretive capability that is required, to ensure its accurate transduction into micro level realities.

Our Approach

In the real world problem-solving in the consulting environment, the demand is for a speedy and approximate solution, rather than a perfect model entailing a long time. In such a context, modelling becomes necessarily pragmatic the primary concern being to formulate a reasonable model in qualitative terms. The required specificity and finer details can be subsequently built in through the associated quantitative models.

Keeping this primary emphasis on pragmatism and approximation in modelling as the guiding philosophy, we adopt in different consulting assignments, a modelling approach which combines both the top-down and bottom-up approaches. The mix is suitably oriented depending on the nature and complexity of the problem situation.

Bottom-up Approach

Under this approach, the basic raw material consists of a set of observations from a variety of observers concerned and familiar with the system. These observations typically belong to lower level sub systems and are in a disaggregated form. These have to be organised into a form which constitutes the basis for identifying the overall system.

Accordingly, we present these observations in the form of a natural model which represents the reality as cognised, without involving any interpretation or inference. No deliberate selection is involved in the choice of variables and their linkages. This provides the first-level complexity map, with all the uncertainties and ambiguities as evidenc on the first sight. The representation usually adopted for this purpose is a Cybernetic Influence Diagram (CID).

A series of such CIDs are prepared over a period, with each successive diagram reflecting greater clarity about the problem. The evolution in the diagrams actually mirrors the depth of our increasing understanding about problem.

After an iterative process, the final cybernetic configuration of the system is crystallised, which becomes the input for the formulation of a formal model. The final CID is decomposed into four fold classification of i)sectors, ii) their needs,iii alterables under the control of the manager, and iv constraints that need to be overcome in the problem situation. These form the basis for developing a set of objectives.which represent the system under study.

These objectives are structured into a **multi-level hierarchical model**, by means of a contextual relationship. This model, represents the **formal system** of the system under study. It actually is an **"Interpretive" Structural Model** which requires very careful interpretation in order to discover the deeper reality of the problem going beyond the apparent structure.

This approach, which is primarily bottom-up, is found to be particularly useful in modelling implicitly hierarchical systems like organisation structures, mission statements(where the meta objective, mission, has beneath it several layers of lower level objectives) and Information Systems.

Top Down Approach

In certain other consulting assignments, active use has been made of the Top-down approach. In some cases, the creative synthesis of data, perceptions of observers and intuition of the consultants results in the emergence of a holistic cognition which captures the essential character of the overall system in a concise way.This insight is then formulated as an integrative statement, which contains within it in an implicit way,layers of detailed features and multiple facets of the system.

In order to identify the detailed structure immanent in the statement, we draw upon appropriate **Generic Models** from General Systems Theory and Cybernetics. These models supply the detailed framework for fleshing out the system. Thus the integrative statement is developed into a detailed model of general nature. This is particularised by interpreting the various sub-systems in the generic model, in terms specific to the problem context.

For example, in a study involving the development of a region, it was felt that representing the region as a living system would help in capturing the essential spirit of the system. Then, the generic model of Living Systems [8] was drawn upon and the subsystems of the region were systematically identified using the Living Systems framework. However, this process required extensive interpretation, especially in identifying sub-systems in the region which correspond to those in LS framework.Similarly,in certain cases, defining systems as viable or evolving systems has led to the use of models like Viable Systems Model [9] and Dissipative Structures. [1]

This approach has been found to be especially valuable in analysing the behaviour of Societal Systems, where the problems are open ended and where, building up from details can lead to disoriented data collection and loss of an overall perspective.

Conclusion

To sum up, the qualitative modelling involving a mix of top-down and bottom-up approaches, has been found to be highly useful in modelling the complex systems and understanding their behaviour. With its natural orientation towards approximation and pragmatism, qualitative modelling has been found to be particularly valuable in analysing real world problems under sever time constraint, which is often the case in a consulting environment. The holistic approach combined with the detailed frameworks provided by the generic models represents a proper balance between the macro and micro aspects, which has made good appeal to the clients.

While no clear cut generalisation is possible, the authors' experience suggests that the bottom up approach is relatively more useful in handling problems at organisational level, while the top down approach has greater validity at the societal level. As for the choice of the particular model, is not generally possible at the outset itself to determine the model appropriate for the problem context on hand. Typically, the consultant experiments with more than one model for some time, till he zeroes on to one. It may be added here that intuition plays no mean role in this choice.

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